CHAPTER 3

PRE-DESIGN EVALUATION OF SITE CONDITIONS

3-1. Environmental and sociopolitical conditions

a. An owner or operator of any facility that treats, stores, or disposes of hazardous waste must be aware of and respond to the concerns of the public in the surrounding communities. In many cases defense installations are physically isolated and treated as separate entities in matters of operations management, land use, and economics. Personnel employed on the base must respond to Army security regulations, thereby defining recreational, public service and housing issues.

b. Health and safety risks are minimized by allowing only authorized personnel into and around restricted hazardous waste treatment, storage or disposal areas. Actual security measures for a facility are given in AR 200-1 and 40 CFR 264 in addition to specific state requirements.

c. If a new Army installation were constructed, an Environmental Impact Statement (EIS) would be required in accordance with AR 200-2; in many cases, projects at existing facilities would also require an EIS or, at minimum, an environmental assessment. The EIS would address the sociopolitical and environmental concerns associated with the planned hazardous waste treatment/disposal facilities. Other activities at the installation may require the approval of local air basin authorities and water quality control boards.

d. Transportation of hazardous waste materials off site requires compliance with state and federal transportation regulations. The potential health risks associated with transport of chemicals on public roads implies that the public and health officials will be concerned and involved.

3-2. Review of relevant site date

a. Prior to the initiation of any design work involving hazardous waste treatment, storage or disposal, the design engineer must become familiar with available records concerning overall site conditions, and those concerning waste types and quantities associated with the particular unit. If an existing unit is being modified to treat an existing waste stream, documentation on the design and engineering aspects of the facility, as well as documentation on the composition and quantity of the waste stream should be available from on-post sources. However, if a new disposal/treatment facility is being designed and constructed to handle new waste streams from either on or off post, a more exhaustive data search will be required.

(1) Data sources available to the design engineer include RCRA-related documents, installation manuals and records, and agency maps, drawings and guidance manuals. Source documents for each facility will vary depending upon the unit to be constructed or modified, the anticipated waste stream, and the record keeping system at the installation. Examples of these data sources include

(a) RCRA-Related Documents:

- Part A Permit Application
- Part B Permit Application
- Hazardous Waste Annual Reports
- Operating Records
- Hazardous Waste Manifests
- Interim Status Documents
- Regulations (regarding design and operating parameters)

(b) Installation Documents:

- Design, Construction and Operating Provisions
- Site Plans; Topographic Maps
- Waste Discharge Requirements
- Environmental Impact Statements
- Installation Assessments
- Spill Prevention Control and Countermeasure Plan
- USATHAMA Records Search Reports
- Standard Operating Procedures
- Department of Defense Form 1348-1 (Item
- Release/Receipt Document)
- DA Form 4508 (Ammunition Transfer Record)
- Waste Inventories
- Site Photographs
- Subsurface and Foundation Investigation Reports
- Installation Master Plan Drawings

(c) State or Federal Agency Documents:

- National Pollutant Discharge Elimination System (NPDES) Permits
- Installation Inspection Reports
- US Geological Survey (USGS) Maps

Federal Emergency Management (FEMA) Flood Insurance Study

- State Geologic and Hydrologic Maps and Reports
- Design Guidance Manuals

(2) A number of these resource documents offer valuable information on the composition and quantities of wastes handled by a given facility. Table 3-1

Table 3-1. Composition and Quantity Data Resources

Specific Source	Authority	Information Available
RCRA Part A Permit Application process	40 CFR 270.1	Identifies, in a cursory manner, the types of wastes generated (coded according to 40 CFR 261 Subpart D), estimated annual generation quantities, the process and design capacities.
RCRA Part B Permit Application	40 CFR 270.14	Requires the submittal of all Interim Status Documents. Pertinent information includes: chemical and physical analysis of hazardous wastes to be handled at the facility, waste analysis plan, description of procedures, structures and equipment, procedures for handling ignitable, reactive, corrosive and incompatible wastes, closure plan, plus specific information pertaining to individual wastes treatment/disposal facilities, (e.g., waste piles, surface impoundments).
Hazardous Waste Annual Reports: (EPA forms 8700-13 and 8700-13A)	40 CFR 262.41 Subpart D	Gives a summation of all waste types and quantities generated during each year. Submitted to EPA and/or state officials.
Hazardous Waste Manifests	40 CFR 264.70 Subpart E	Identifies waste transported to the site and off site; includes proper shipping names, hazard class (49 CFR Part 172), weight or volume, components and concentration range. Copies of the manifest must be kept at the facility for at least three years.
Operating Records	40 CFR 264.73	Description and quantity of each hazardous waste received and the methods and dates of treatment, storage or disposal; records maintained until facility closure.
DD Form 1348-1: (DOD Single Line Release/Receipt Document)	AR200-1 Paragraph 5-6(d)	Identifies (DPDO) material or waste, its origination and destination, type and number of containers, material condition, and freight classification.
Spill Prevention Control and Countermeasure (SPCC) Plan	Section 311 of the Clean Water Act PL 95-217 AR 200-1 (paragraph 8-6)	Inventory of all sources of oil and hazardous substances
National Pollutant Discharge Elimination System (NPDES) Permit	Section 402 of the Clean Water Act PL 95-217	Permit specifies the type and quantities of liquid wastes that may be discharged into the nation's water sources.

US Army Corps of Engineers

reviews the kind of information available in some of these documents.

(3) Interviews with facility or installation personnel in connection with site visits will aid in the collection and interpretation of the various sources of information on waste generation and site conditions. The Defense Property Disposal Office has chemical inventories of both waste materials and off-spec supplies (being stored for resale). Many installations have an Environmental Office which is responsible for securing permits, record keeping, and waste stream update information.

b. Information may also be obtained from off-site resources. The following is a partial list of sources:

- US EPA Office of Solid Waste
- US EPA Municipal Environmental Research Laboratory
- US Army Environmental Hygiene Agency
- US Army Toxic and Hazardous Materials Agency
- US Army Corp of Engineers' Research and Development Laboratories (WES, CERL and CRREL)
- Defense Logistics Agency

Public Libraries (EIR, EIS, local and state requirements)
State Health Department

3-3. Hydroge9logic conditions

a. Protection of ground-water resources is a primary concern in the design and operation of any facility involved with the handling of wastes. The potential for pollution can develop if wastes are placed in improper hydrogeologic settings where wastes and/or leachate products may easily enter the ground-water system.

(1) Ground-water protection has been one of EPA's central concerns in devising a regulatory strategy for hazardous waste land disposal. A large number of the documented damage cases for hazardous waste land disposal have involved ground-water contamination. Likewise the legislative history of RCRA, including the damage cases cited in the 1976 Senate Report, indicates that the Congress was quite concerned about ground-water contamination when it created the hazardous waste program. Accordingly, today's regulations deal very explicitly with ground-water protection.

(2) Ground-water protection can be ensured only

through a clear understanding of the hydrogeologic environment in which the wastes are to be placed. Hydrogeologic considerations to be addressed include:

- Review of published and unpublished data on ground-water availability and quality
- Ground-water flow quantity and direction under the site *
- Relationship of the site to ground-water basin recharge areas
- Ground-water use near the site, including review of available well logs and water well inventories (available from some state agencies)
- Identification of uppermost aquifers
- Location of regional aquifers and aquicludes and regional flow information

b. Protection of surface-water resources is another important concern in the design and operation of a hazardous waste land disposal/land treatment facility. A surface-water assessment of the site is recommended to determine (1) water quality of streams and other surface-water sources within the area, and (2) the ratio of baseflow discharge from upstream sources to any potential permitted discharges (to determine how much dilution occurs).

c. Information relating to regional and site hydrogeologic conditions on the following is also required:

- Geologic mapping of the site.
- Detailed boring logs and test pits of subsurface soils and geology characterizing the base of the uppermost aquifer.
- Detailed chemical analysis of all aquifers that are potential water supply sources or which have the potential for contamination.
- Surface elevations and drainage.
- Soil classification and geotechnical properties.
- Measurement of permeability of soils and formations between the base of the disposal unit and uppermost aquifer.

d. A comprehensive geotechnical testing program might include:

- Soil classification tests.
- Compaction tests.
- Unconfined compressive strength tests.
- Triaxial compression tests.
- Direct shear tests.
- Permeability testing.
- Background contaminant level tests (EM 11102-1906).

These tests are typically conducted in accordance with American Society for Testing and Materials (ASTM) methods.

e. Methods of approach for site investigations may be found in Design of Small Dams, US Department of Interior (1973), TM 5-818-1, NAVFAC DM 7.1 and EPA Manual SW-963.

f. Subsurface information obtained from boring logs may also be supplemented by geophysical methods. Geophysical surveys give the designer the advantage of examining large areas at one time, facilitating the correlation of borehole data around the site and delineation of overall site geology. However, it is important to note that the usefulness of a given geophysical method is dependent on site-specific conditions and must be assessed on a case-by-case basis. Geophysical methods include:

(1) Electrical "E" Logs-This process involves measuring electrical properties of soils and geologic formations in uncased boreholes. The data collected will yield information on potential of strata to transmit water, occurrence of water and general water quality. Cost may vary depending on hole depth and condition.

(2) Electrical Resistivity Survey-This method employs vertical electrical soundings (VES) which transmit electrical currents into the ground. The VES may be considered an electrical "drill hole" which may define subsurface strata. This relatively inexpensive technique enables rapid evaluation of subsurface conditions to a depth of approximately 200 feet.

(3) Magnetometer Survey-This method measures magnetic intensity of rock and strata for defining geologic structure. Magnetometer surveys can cover large areas at minimum cost.

(4) Seismic Refraction Survey-Seismic refraction surveys use sonic waves created by small explosions (or sledge hammer or other vibro-mechanical means) to map variations in bedrock hardness. These surveys can provide information on competency of bedrock (indicative of rock rippability) and degree of weathering, as well as changes in these properties with depth. Seismic surveys are capable of scanning large areas for a moderate cost.

g. Additional information on regional seismicity is required in seismically active areas of the United States: 40 CFR 264.18 requires special seismic studies for new hazardous waste facilities in a number of western and midwestern states. Appendix VI to part 264 lists political jurisdiction for which this requirement is mandated. The design engineer is also advised to review seismic zone maps presented in TM 5-809-10 (para 3-4) for additional information. In seismically active areas, the services of a soils engineer familiar with seismic engineering may be needed to determine the effects of seismic loads to foundations and fills caused by ground acceleration and shaking. Static and dynamic analysis may be required to predict potential slope failure.

h. In summary, data evaluation is critical to individual facility siting and must consider maximum advantage of the site's hydrogeologic and geotechnical factors. Assessment of soil engineering properties will dictate types of design and availability of on-site mate rial. All facilities must be designed for specialized problems such as seismic shaking in seismically active areas, o expansive soils.

3-4. Climatic elements

a. Climatic conditions, particularly precipitation, evaporation, temperature, and wind, can significantly influence the selection, design and operation of land disposal facilities. Adverse climatic conditions can, for example:

(1) Prevent use or operation of
- Surface Impoundments practicing evaporative disposal of wastes, if annual precipitation is greater than annual evaporation.
- Land Treatment facilities, if soils in the treatment area are frozen or saturated.

(2) Restrict operation of—
- Surface Impoundments, where heavy rainfall reduces storage capacity.
- Land Treatment facilities, where lower temperatures will decrease biodegradation rates.
- Landfills, where (1) freezing soil or wastes interfere with proper placement of compaction of wastes, soil cover or earthfills, (2) accumulation of snow may require clearing, or (3) snow melt may increase the moisture content of the waste.

(3) Impact closure practices at impoundments and landfills
- Disruption of the compacted soil zone through frost heave (water migration and freezing in layers, lenses or veins of ice).
- Sliding resulting from thawing of a shallow, saturated zone of soil cover.
- Rainfall erosion of the soil cover.

b. Generalized climatic data are available from the National Climatic Center of the National Oceanic and Atmospheric Administration and the National Weather Service. Local meteorological data is often available at Army installations that have air fields. In addition, some states have official weather observation stations that offer climatic data. Selected publications which provide recorded data, frequency and duration analyses, and general charts for various climatic elements are listed in the references (appendix A).

c. Another source of information is the US Weather Bureau, whose 300 first-order weather stations provide data on:

- Daily and monthly temperature
- Dewpoint
- Precipitation
- Pressure
- Wind
- Sunshine and cloud cover
- Solar radiation

d. Weather stations also publish climatic tables of normal, mean and extreme values for long periods of record and climatic maps of the United States. Design data directly available from the US Weather Bureau include isobars for 24-hour rainfalls and for average annual lake evaporation.

e. In addition, numerous theories, empirical correlations, modeling procedures and charts have been developed for defining and predicting the impact of climatic elements on design. Those useful in designing land disposal facilities include equations for infiltration and run off, rainfall and wind erosion, and wind waves; depth of freezing indices; and evaporation/evapotranspiration calculations. State and local agencies have used available climatic data to develop charts and tables which can be used in these predictive calculations-including the rainfall and storm recurrence tables and rainfall intensity/duration charts used for run-off calculations.

3-5. Impact of site conditions on selection of disposal method

a. Most regulations dealing with disposal to land clearly reflect the sensitive relationship between waste type, disposal method, and potential for natural or engineered protection of the environment at the proposed disposal facility. Sites that are designed to accept only solid, generally inert substances, obviously require fewer natural containment features than do those intended for liquid hazardous waste. Similarly, siting of waste piles or land treatment facilities may be far less restrictive than siting of impoundments.

b. Site conditions which obviously prohibit development of a disposal site of any type are wetlands and locations in critical aquifer recharge areas. Site conditions that impact selection of disposal methods fall into three basic areas (1) ability for ground-water protection, (2) potential for surface water contact with wastes, and (3) availability of materials required by each disposal method. Almost any negative site condition can be overcome by engineering designs; however, these engineering solutions can often result in unacceptable economic impacts and/or regulatory monitoring requirements.

(1) In selecting a disposal method, two key elements regarding ground-water protection must be considered: (1) vertical separation of wastes from the uppermost ground-water, and (2) permeability of the subsurface material providing the hydraulic separation. These two elements are interrelated. Far less separation between waste and ground-water can be tolerated in a low permeability clay environment than in a site underlain by sand and gravel. However, design considerations of the natural ground-water setting can be greatly influenced by regulations mandated by 40 CFR 264 requiring the placement of impermeable liners beneath landfills, impoundments and waste piles.

(a) Surface impoundments should be sited and designed with maximum protection of ground water provided by liners, low permeability clay (10-8 cm/sec) underlying soils, and maximum separation. The hydraulic head formed in the impoundment provides for a high potential for liquid seepage and subsurface migration.

(b) Since potential for buildup of hydraulic head in landfills and waste piles is much less than for impoundments, siting criteria can be somewhat relaxed for these facilities. With liners beneath the waste, soils with permeabilities in the vicinity of 10-6 cm/sec (silts, silty clays) may be acceptable separation materials.

(c) In land treatment facilities little or no hydraulic head buildup is created; however, strict operational criteria are required by RCRA to ensure their protection. Such facilities can be located in most locales that provide a minimum separation from groundwater of approximately 10 feet, and moderately low permeability soils (10-4 to 10-5 cm/sec-silty sands, silts).

(d) Limitations in locating injection wells are discussed in paragraph 5-5.

(2) Isolation of wastes from surface water is a major concern in the design and locating of all disposal methods. It is highly recommended that disposal units be located out of a 100-year flood plain and away from topographic areas prone to flash flooding and/or severe erosion; avoidance of flood plain areas may be mandatory for certain types of hazardous wastes. All disposal modes (landfills, impoundments, etc.) should be designed with drainage diversion and surface run on protection and isolation facilities (i.e., berms, dikes, etc.). High design and construction costs may be associated with sites located within flood areas and/or in areas requiring diversion of surface runoff from large upgradient watersheds. With proper facility design, surface water conditions should not be a major factor in selection of a disposal type, but only in selection of design criteria.

(3) Each disposal type has its own soil requirements for construction and operation. Although all materials can be imported from off-site sources, project costs can, as a result, become prohibitive. In sites located in areas underlain by shallow cemented bedrock, nearly all soil materials may need to be imported; as a result, costs for landfilling in such areas can be prohibitive. Sites underlain by clay deposits significantly reduce the cost of construction of all types of disposal facilities. Below is a summary of soil needs for different disposal methods:

Disposal Type	*Soil Needs*
Landfill	Daily and intermediate cover; a variety of soil types are acceptable. Final cover soils must be low permeability clays. Liner soil must be clay.
Surface Impoundments	Liner soil must be low permeability clay.
Waste Piles	Liner soil must be low permeability clay.
Land Treatment	Treatment zone must have minimum of 5 feet of suitable soil, as described in section 5-4 b (2).

3-6. Design requirements imposed by hydrogeologic conditions

Less than ideal hydrogeologic conditions can be overcome by engineering designs in all but the most extreme conditions. However, the site owner/operator must be aware that great expense may be involved in these engineering solutions, and may make the project economically unfeasible. Table 3-2 summarizes the major design/operational requirements imposed by unfavorable hydrogeologic conditions.

Table 3-2. Design/Operational Requirements Imposed by Hydrogeologic Conditions

Unfavorable Hydrogeologic Conditions	Requirements
Ground Water	
High ground-water table	Placement of impermeable liners; dewatering systems to lower ground water; increased monitor
High permeability soils	ing.
Surface Water	
Within flood plain	Construction of perimeter dikesnevees; liners to interrupt connection between ground and surface
Inter-related to shallow ground water beneath facility	waters; construction of drainage diversion facilities.
Extensive upgradient watershed	
Faults	Location of facilities outside of a fault buffer zone.
Soils	
Inadequate soils for cover or impermeable barriers*	Importation of soils that meet regulatory requirements.
Active Karst Zones	
Sinkhole-prone areas	Location of facilities outside of active Karst zones is recommended.
Solution channels	

*As used here, inadequate means either (1) unable to meet regulatory requirements for soil type and permeability, or (2) insufficient quantities to meet design/operational needs.